

WHAT IS CLAIMED IS:

1. An image processing apparatus which multiplexes noise on multilevel image data to embed visible additional information with a noise-multiplexed distribution,

5 comprising:

input means for inputting, as the additional information, information representing whether or not to multiplex noise for each pixel;

determination means for determining on the basis of
10 the additional information whether a pixel of interest in the multilevel image data is located at a position where noise is to be multiplexed;

specifying means for, when said determination means determines that the pixel of interest is located at the
15 position where noise is to be multiplexed, specifying a bit region where noise is to be multiplexed on the basis of data of a neighboring region near the pixel of interest; and

change means for reversibly changing bit information for the bit region of the pixel of interest specified by
20 said specifying means.

2. The apparatus according to claim 1, further comprising means for setting information on an intensity for multiplexing noise, and

said specifying means specifies the bit region where
25 noise is to be multiplexed on the basis of the set information on the intensity and data of the neighboring region.

3. An image processing apparatus which removes visible additional information from multilevel image data in which noise is reversibly embedded to multiplex the visible additional information, comprising:

5 input means for inputting, as the additional information, information representing whether or not to multiplex noise for each pixel;

 determination means for determining on the basis of the additional information whether a pixel of interest in
10 the multilevel image data is located at a position where noise is multiplexed;

 specifying means for, when said determination means determines that the pixel of interest is located at the position where noise is multiplexed, specifying a bit
15 region where noise is multiplexed on the basis of data of a neighboring region having undergone removal processing near the pixel of interest; and

 reconstruction means for performing conversion inverse to noise multiplexing to reconstruct a state of the
20 bit region of the pixel of interest specified by said specifying means into a state before multiplexing.

4. An image processing method of multiplexing noise on multilevel image data to embed visible additional information with a noise-multiplexed distribution,
25 comprising:

 an input step of inputting, as the additional information, information representing whether or not to

multiplex noise for each pixel;

a determination step of determining on the basis of the additional information whether a pixel of interest in the multilevel image data is located at a position where
5 noise is to be multiplexed;

a specifying step of, when the pixel of interest is determined in the determination step to be located at the position where noise is to be multiplexed, specifying a bit region where noise is to be multiplexed on the basis of data
10 of a neighboring region near the pixel of interest; and

a change step of reversibly changing bit information for the bit region of the pixel of interest specified in the specifying step.

5. An image processing method of removing visible
15 additional information from multilevel image data in which noise is reversibly embedded to multiplex the visible additional information, comprising:

an input step of inputting, as the additional information, information representing whether or not to
20 multiplex noise for each pixel;

a determination step of determining on the basis of the additional information whether a pixel of interest in the multilevel image data is located at a position where noise is multiplexed;

25 a specifying step of, when the pixel of interest is determined in the determination step to be located at the position where noise is multiplexed, specifying a bit

region where noise is multiplexed on the basis of data of a neighboring region having undergone removal processing near the pixel of interest; and

a reconstruction step of performing conversion
5 inverse to noise multiplexing to reconstruct a state of the bit region of the pixel of interest specified in the specifying step into a state before multiplexing.

6. A computer program functioning as an image processing apparatus which multiplexes noise on multilevel image data
10 to embed visible additional information with a noise-multiplexed distribution, functioning as:

input means for inputting, as the additional information, information representing whether or not to multiplex noise for each pixel;

15 determination means for determining on the basis of the additional information whether a pixel of interest in the multilevel image data is located at a position where noise is to be multiplexed;

specifying means for, when said determination means
20 determines that the pixel of interest is located at the position where noise is to be multiplexed, specifying a bit region where noise is to be multiplexed on the basis of data of a neighboring region near the pixel of interest; and

change means for reversibly changing bit information
25 for the bit region of the pixel of interest specified by said specifying means.

7. A computer-readable storage medium storing a

computer program defined in claim 6.

8. A computer program functioning as an image processing apparatus which removes visible additional information from multilevel image data in which noise is reversibly embedded to multiplex the visible additional information, functioning as:

input means for inputting, as the additional information, information representing whether or not to multiplex noise for each pixel;

10 determination means for determining on the basis of the additional information whether a pixel of interest in the multilevel image data is located at a position where noise is multiplexed;

specifying means for, when said determination means determines that the pixel of interest is located at the position where noise is multiplexed, specifying a bit region where noise is multiplexed on the basis of data of a neighboring region having undergone removal processing near the pixel of interest; and

20 reconstruction means for performing conversion inverse to noise multiplexing to reconstruct a state of the bit region of the pixel of interest specified by said specifying means into a state before multiplexing.

9. A computer-readable storage medium storing a computer program defined in claim 8.

10. An image processing apparatus which converts multilevel image data into frequency component data for

each pixel block of a predetermined size to
compression-code the multilevel image data, and
multiplexes noise on the multilevel image to embed visible
additional information with a noise-multiplexed

5 distribution, comprising:

input means for inputting, as the additional
information, information representing whether or not to
multiplex noise for each pixel block of the predetermined
size;

10 determination means for determining on the basis of
the input additional information whether a pixel block of
interest is located at a position where noise is to be
multiplexed;

specifying means for, when said determination means
15 determines that the pixel block of interest is located at
the position where noise is to be multiplexed, specifying
a bit region where noise is to be multiplexed in data
constituting a converted low frequency component of the
pixel block of interest on the basis of a reference region
20 serving as a converted low frequency component of a
neighboring pixel block near the pixel block of interest;
and

change means for reversibly changing bit information
for the bit region in the data of the low frequency component
25 specified by said specifying means.

11. An image processing apparatus which converts
multilevel image data into frequency component data for

each pixel block of a predetermined size to
compression-code the multilevel image data, and
multiplexes noise on the multilevel image to embed visible
additional information with a noise-multiplexed

5 distribution, comprising:

input means for inputting, as the additional
information, information representing whether or not to
multiplex noise for each pixel block of the predetermined
size;

10 determination means for determining on the basis of
the input additional information whether a pixel block of
interest is located at a position where noise is to be
multiplexed;

specifying means for, when said determination means
15 determines that the pixel block of interest is located at
the position where noise is to be multiplexed, specifying
a bit region where noise is to be multiplexed in data
constituting a low frequency component of the pixel block
of interest on the basis of a reference region serving as
20 a converted high frequency component of the pixel block of
interest; and

change means for reversibly changing bit information
for the bit region in the data of the low frequency component
specified by said specifying means.

25 12. The apparatus according to claim 10, wherein the
conversion into the frequency component includes
orthogonal transform, and the low frequency component

includes a DC component after orthogonal transform.

13. The apparatus according to claim 12, wherein the conversion into the frequency component includes wavelet transform, and the low frequency component includes data
5 of a block of a low frequency component that is generated by wavelet transform a plurality of number of times.

14. The apparatus according to claim 10, further comprising means for setting information on an intensity for multiplexing noise, and

10 said specifying means specifies the bit region where noise is to be multiplexed at the low frequency component of the pixel block of interest on the basis of the set information on the intensity and the reference region.

15. An image processing apparatus which removes visible
15 additional information from multilevel image data that is compression-coded by reversibly embedding noise, multiplexing the visible additional information, and converting the data into frequency component data for each pixel block of a predetermined size, comprising:

20 input means for inputting, as the additional information, information representing whether or not to multiplex noise for each pixel block of the predetermined size;

determination means for determining on the basis of
25 the input additional information whether a pixel block of interest is located at a position where noise is multiplexed;

specifying means for, when said determination means determines that the pixel block of interest is located at the position where noise is multiplexed, specifying a bit region where noise is multiplexed at a converted low
5 frequency component of the pixel block of interest on the basis of a reference region serving as a converted low frequency component of a neighboring pixel block near the pixel block of interest; and

reconstruction means for performing conversion
10 inverse to noise multiplexing to reconstruct a state of the bit region at the low frequency component of the pixel block of interest specified by said specifying means into a state before multiplexing.

16. An image processing apparatus which removes visible
15 additional information from multilevel image data that is compression-coded by reversibly embedding noise, multiplexing the visible additional information, and converting the data into frequency component data for each pixel block of a predetermined size, comprising:

20 input means for inputting, as the additional information, information representing whether or not to multiplex noise for each pixel block of the predetermined size;

determination means for determining on the basis of
25 the input additional information whether a pixel block of interest is located at a position where noise is multiplexed;

specifying means for, when said determination means determines that the pixel block of interest is located at the position where noise is multiplexed, specifying a bit region where noise is multiplexed at a low frequency component of the block of interest on the basis of a reference region serving as a converted high frequency component of the pixel block of interest; and

reconstruction means for performing conversion inverse to noise multiplexing to reconstruct a state of the bit region at the low frequency component of the pixel block of interest specified by said specifying means into a state before multiplexing.

17. An image processing method of converting multilevel image data into frequency component data for each pixel block of a predetermined size to compression-code the multilevel image data, and multiplexing noise on the multilevel image to embed visible additional information with a noise-multiplexed distribution, comprising:

an input step of inputting, as the additional information, information representing whether or not to multiplex noise for each pixel block of the predetermined size;

a determination step of determining on the basis of the input additional information whether a pixel block of interest is located at a position where noise is to be multiplexed;

a specifying step of, when the pixel block of interest

is determined in the determination step to be located at the position where noise is to be multiplexed, specifying a bit region where noise is to be multiplexed in data constituting a converted low frequency component of the pixel block of interest on the basis of a reference region serving as a converted low frequency component of a neighboring pixel block near the pixel block of interest; and

a change step of reversibly changing bit information for the bit region in the data of the low frequency component specified in the specifying step.

18. An image processing method of converting multilevel image data into frequency component data for each pixel block of a predetermined size to compression-code the multilevel image data, and multiplexing noise on the multilevel image to embed visible additional information with a noise-multiplexed distribution, comprising:

an input step of inputting, as the additional information, information representing whether or not to multiplex noise for each pixel block of the predetermined size;

a determination step of determining on the basis of the input additional information whether a pixel block of interest is located at a position where noise is to be multiplexed;

a specifying step of, when the pixel block of interest is determined in the determination step to be located at

the position where noise is to be multiplexed, specifying a bit region where noise is to be multiplexed in data constituting a low frequency component of the pixel block of interest on the basis of a reference region serving as a converted high frequency component of the pixel block of interest; and

a change step of reversibly changing bit information for the bit region in the data of the low frequency component specified in the specifying step.

10 19. An image processing method of removing visible additional information from multilevel image data that is compression-coded by reversibly embedding noise, multiplexing the visible additional information, and converting the data into frequency component data for each pixel block of a predetermined size, comprising:

15 an input step of inputting, as the additional information, information representing whether or not to multiplex noise for each pixel block of the predetermined size;

20 a determination step of determining on the basis of the input additional information whether a pixel block of interest is located at a position where noise is multiplexed;

a specifying step of, when the pixel block of interest is determined in the determination step to be located at the position where noise is multiplexed, specifying a bit region where noise is multiplexed at a converted low

frequency component of the pixel block of interest on the basis of a reference region serving as a converted low frequency component of a neighboring pixel block near the pixel block of interest; and

5 a reconstruction step of performing conversion inverse to noise multiplexing to reconstruct a state of the bit region at the low frequency component of the pixel block of interest specified in the specifying step into a state before multiplexing.

10 20. An image processing method of removing visible additional information from multilevel image data that is compression-coded by reversibly embedding noise, multiplexing the visible additional information, and converting the data into frequency component data for each
15 pixel block of a predetermined size, comprising:

 an input step of inputting, as the additional information, information representing whether or not to multiplex noise for each pixel block of the predetermined size;

20 a determination step of determining on the basis of the input additional information whether a pixel block of interest is located at a position where noise is multiplexed;

 a specifying step of, when the pixel block of interest
25 is determined in the determination step to be located at the position where noise is multiplexed, specifying a bit region where noise is multiplexed at a low frequency

component of the block of interest on the basis of a reference region serving as a converted high frequency component of the pixel block of interest; and

a reconstruction step of performing conversion
5 inverse to noise multiplexing to reconstruct a state of the bit region at the low frequency component of the pixel block of interest specified in the specifying step into a state before multiplexing.

21. A computer program functioning as an image processing
10 apparatus which converts multilevel image data into frequency component data for each pixel block of a predetermined size to compression-code the multilevel image data, and multiplexes noise on the multilevel image to embed visible additional information with a
15 noise-multiplexed distribution, functioning as:

input means for inputting, as the additional information, information representing whether or not to multiplex noise for each pixel block of the predetermined size;

20 determination means for determining on the basis of the input additional information whether a pixel block of interest is located at a position where noise is to be multiplexed;

specifying means for, when said determination means
25 determines that the pixel block of interest is located at the position where noise is to be multiplexed, specifying a bit region where noise is to be multiplexed in data

constituting a converted low frequency component of the pixel block of interest on the basis of a reference region serving as a converted low frequency component of a neighboring pixel block near the pixel block of interest;

5 and

change means for reversibly changing bit information for the bit region in the data of the low frequency component specified by said specifying means.

22. A computer-readable storage medium storing a
10 computer program defined in claim 21.

23. A computer program functioning as an image processing apparatus which converts multilevel image data into frequency component data for each pixel block of a predetermined size to compression-code the multilevel
15 image data, and multiplexes noise on the multilevel image to embed visible additional information with a noise-multiplexed distribution, functioning as:

input means for inputting, as the additional information, information representing whether or not to
20 multiplex noise for each pixel block of the predetermined size;

determination means for determining on the basis of the input additional information whether a pixel block of interest is located at a position where noise is to be
25 multiplexed;

specifying means for, when said determination means determines that the pixel block of interest is located at

the position where noise is to be multiplexed, specifying a bit region where noise is to be multiplexed in data constituting a low frequency component of the pixel block of interest on the basis of a reference region serving as
5 a converted high frequency component of the pixel block of interest; and

change means for reversibly changing bit information for the bit region in the data of the low frequency component specified by said specifying means.

10 24. A computer-readable storage medium storing a computer program defined in claim 23.

25. A computer program functioning as an image processing apparatus which removes visible additional information from multilevel image data that is compression-coded by
15 reversibly embedding noise, multiplexing the visible additional information, and converting the data into frequency component data for each pixel block of a predetermined size, functioning as:

input means for inputting, as the additional
20 information, information representing whether or not to multiplex noise for each pixel block of the predetermined size;

determination means for determining on the basis of the input additional information whether a pixel block of
25 interest is located at a position where noise is multiplexed;

specifying means for, when said determination means

determines that the pixel block of interest is located at the position where noise is multiplexed, specifying a bit region where noise is multiplexed at a converted low frequency component of the pixel block of interest on the basis of a reference region serving as a converted low frequency component of a neighboring pixel block near the pixel block of interest; and

reconstruction means for performing conversion inverse to noise multiplexing to reconstruct a state of the bit region at the low frequency component of the pixel block of interest specified by said specifying means into a state before multiplexing.

26. A computer-readable storage medium storing a computer program defined in claim 25.

27. A computer program functioning as an image processing apparatus which removes visible additional information from multilevel image data that is compression-coded by reversibly embedding noise, multiplexing the visible additional information, and converting the data into frequency component data for each pixel block of a predetermined size, functioning as:

input means for inputting, as the additional information, information representing whether or not to multiplex noise for each pixel block of the predetermined size;

determination means for determining on the basis of the input additional information whether a pixel block of

interest is located at a position where noise is multiplexed;

specifying means for, when said determination means determines that the pixel block of interest is located at the position where noise is multiplexed, specifying a bit region where noise is multiplexed at a low frequency component of the block of interest on the basis of a reference region serving as a converted high frequency component of the pixel block of interest; and

reconstruction means for performing conversion inverse to noise multiplexing to reconstruct a state of the bit region at the low frequency component of the pixel block of interest specified by said specifying means into a state before multiplexing.

28. A computer-readable storage medium storing a computer program defined in claim 27.